REMARKS

Claims 1, 4, 5, 7, and 8 are pending in the present application.

Claims 2, 3, and 6 have been cancelled without prejudice or disclaimer to the subject matter contained therein.

I. ARGUMENTS

A. Objection to the Drawings

The drawings have been objected for various reasons. These objections are respectfully traversed in view of the above-submitted amendments to the Specification and drawings.

As submitted above, the specification has been amended to clarify the relationship between reference 30 of Figure 2 and source 12 of Figure 1. More specifically, Figure 1 has been amended to show the connection between the check valve and the reservoir. Figure 2 has been amended to identify the outlet 30 of source (12).

No new subject matter has been added in these amendments.

Accordingly, in view of the amendments and remarks set forth above, the Examiner is respectfully requested to reconsider and withdraw these objections to the drawings.

B. Objection to the Specification

The specification has been objected for various reasons. This objection is respectfully traversed in view of the above-submitted amendments to the specification and claims.

As submitted above, the specification has been amended to indicate that the beryllium target 32 produces a neutron flux. Moreover, the specification has been amended such that the description of Figure 1 does not recite element 30. Also, the

specification has been amended to clarify the relationship between reference 30 of Figure 2 and source 12 of Figure 2.

No new subject matter has been added in these amendments.

Accordingly, in view of the amendments and remarks set forth above, the Examiner is respectfully requested to reconsider and withdraw this objection.

C. Rejection of Claims 1, 2, and 4 - 8 under 35 U.S.C. §112, First Paragraph

Claims 1, 2, and 4-8 have been rejected under 35 U.S.C. §112, first paragraph, for failing to provide a written description of the claimed invention. This rejection, in view of the above amendments, is moot.

In formulating the rejection under 35 U.S.C. §112, first paragraph, the Examiner alleges that the originally filed specification fails to provide a written description of a nozzle submerged in liquid gallium.

Figure 2 is a cross-sectional illustration of the neutron generating portion of the accelerator based neutron source 12 of Figure 1 and associated cooling system. The portion of the accelerator based neutron source 12, as set forth in the originally filed specification, includes a stainless steel housing 31 within which is a beryllium target 32. This target is bombarded with either protons or deuterons on a surface 33 of the beryllium target 32. As a result of proton or deuteron interactions in the beryllium target 32, neutrons are generated and pass through the gallium-filled reservoir and stainless steel housing and are emitted from the accelerator based neutron source 12, as set forth in the originally filed specification. Since the heat flux in the beryllium is extremely high, the present invention utilizes liquid gallium to cool the beryllium target 32.

The accelerator based neutron source 12, as illustrated in original Figure 2 and as set forth in the originally filed specification, includes a stainless steel nozzle 34 that receives the liquid gallium and injects a concentrated jet of liquid gallium 37 onto the back surface 39 of the beryllium target 32. Since the outlet 30, as illustrated in original Figure 2, from the stainless steel housing 31 is located above the top surface of the

beryllium target 32, the reservoir 40 will fill with liquid gallium, as set forth in the originally filed specification.

Thus, the originally filed specification teaches that the jet of liquid gallium 37 is submerged in the reservoir 40 because the reservoir 40 will fill with liquid gallium.

The liquid gallium will exit out of the housing through the outlet 30 where it will be piped to the heat exchanger 24 to remove the latent heat.

In addressing the Applicant's arguments, the Examiner alleges that Figure 2 fails to illustrate that nozzle 34 is even in chamber 40. This assertion by the Examiner is unsupportable in view of the original specification. The original Specification indicates that Figure 2 is a cross-sectional illustration of the neutron generating portion of the accelerator based neutron source 12. Thus, Figure 2 illustrates all objects with respect to a certain plane. Since nozzle 34 is illustrated with chamber 40 and the illustration is a cross-sectional view, nozzle 34 must be in chamber 40, otherwise the view cannot be a cross-sectional view.

The Examiner further counters that even if the nozzle 34 is in chamber 40, the original specification fails to teach if the chamber 40 is filled enough to submerge the nozzle 34. The original specification explicitly states that the liquid gallium **fills** the chamber 40. The original specification does **NOT** teach a partial fill. Thus, the ordinary meaning of the original specification clearly teaches the skilled artisan that the chamber 40 is filled enough to submerge the nozzle 34.

As noted previously, the original specification indicates that the testing of the invention with a water coolant produced a submerged jet. Thus, the same configuration using liquid gallium would produce a submerged jet. As taught by Pais et al., a submerged jet is realized from a submerged nozzle.

However, the Examiner argues that Pais et al. teaches the existence of a submerged jet without realizing a submerged nozzle. This position is contrary to the explicit teachings of Pais et al. More specifically, Pais et al. teaches, at the end of the article, on page 182, that "in all of the above cases the surface [target] and nozzle were fully submerged." The submerged nozzle, as taught by Pais et al., created a

submerged jet. Thereafter, Pais et al. teaches a free jet impingement configuration wherein the nozzle is not submerged. Therefore, contrary to the Examiner's contentions, only teaches the existence of a submerged jet using a submerged nozzle and does not teach or even suggest the existence of a submerged jet without realizing a submerged nozzle.

The Examiner contends that since pages 7 and 8 of the original specification does not mention a submerged jet or submerged nozzle when describing a liquid gallium test, the specification clearly fails to a submerged nozzle. It is noted that pages 7 and 8 also do not mention the chamber, the heat exchanger, etc. In view of this omission, it appears that the Examiner would contend that the original specification also does not support any elements of the claims because the description of the liquid gallium test fails to mention each of the claimed elements.

Lastly, the Examiner contends that the disclosure is silent with respect to the outlet being located at the top surface of the target. Notwithstanding, the Examiner asserts that the nozzle 34 of Figure 2 of the above-identified application need not be submerged when producing a submerged jet. To support this assertion, the Applicant respectfully request the Examiner to clearly demonstrate how the liquid gallium travels from the nozzle to produced a submerged jet which impinges upon the target and exits out the outlet without submerging the nozzle.

To demonstrate the Applicant's position, Figure 2 has been annotated to show the necessary liquid gallium level to facilitate both exiting from the outlet and creating a submerged jet.

In the first annotation of Figure 2, the neutron generating portion of the accelerator based neutron source is orientated such that the outlet is above the nozzle. In this annotation, it is very clear that the level **A** of the liquid gallium would be such to submerge the nozzle in order to both exit the outlet and create a submerged jet 37.

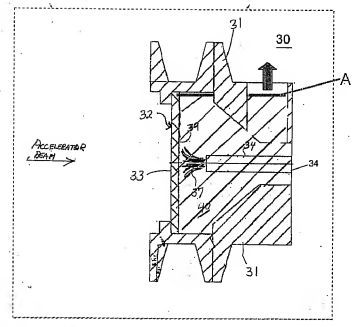


FIG. 2

In the second annotation of Figure 2, the neutron generating portion of the accelerator based neutron source is orientated such that the outlet is below the nozzle. In this annotation, it is very clear that the level **A** of the liquid gallium would be such to submerge the nozzle in order to both exit the outlet and create a submerged jet 37.

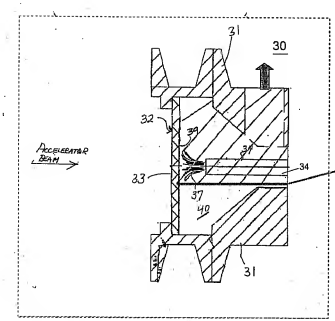


FIG. 2

Accordingly, in view of the remarks set forth above, the Examiner is respectfully requested to reconsider and withdraw this rejection.

D. Rejection of Claims 1 and 5 under 35 U.S.C. §103

Claims 1, 4, 5, and 7 have been rejected under 35 U.S.C. §103 as being unpatentable over Eggers (US-A-5,392,319) in view of Lidsky et al. (US-A-5,784,423) and Pias et al. (IEEE Article). This rejection is respectfully traversed.

Independent Claim 1

As submitted above, independent claim 1 sets forth a method of cooling a low Z target material of a neutron source assembly by providing, by using a nozzle submerged in liquid gallium, a submerged jet of concentrated liquid gallium in a

direction normal to a non-bombarded surface of the low Z target material within the neutron source assembly to cool the low Z target material; providing a reservoir of liquid gallium; and pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir.

Initially, as recognized by the Examiner, Eggers fails to disclose cooling a low Z target material of a neutron source assembly with liquid gallium. To meet this deficiency in Eggers, the Examiner assets that Eggers can be modified by the teachings of Lidsky et al. because the Examiner alleges that the teaching of Lidsky et al. with respect to cooling a low Z target material of a neutron source assembly with liquid gallium is an acceptable equivalent to cooling with water as taught by Eggers. The Examiner's motivation is incorrect.

More specifically, the liquid gallium of Lidsky et al. is incompatible with the system of Eggers because Eggers discloses a neutron source assembly constructed of aluminum. Liquid gallium dissolves aluminum or copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Eggers with the teaching of Lidsky et al. to realize a system to cool a low Z target material of a neutron source assembly with liquid gallium because the liquid gallium would dissolve the aluminum neutron source assembly of Eggers.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the aluminum neutron source assembly of Eggers, the proposed combination of Eggers, Lidsky et al., and Pais et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Eggers in that the system of Eggers would be rendered inoperable if liquid gallium were utilized as a coolant.

Moreover, as recognized by the Examiner, Eggers, and Lidsky et al., singly or in combination, fail to disclose a nozzle submerged in liquid gallium. To meet this deficiency in Eggers, and Lidsky et al., the Examiner assets that Eggers and Lidsky et

al. can be modified by the teachings of Pais et al. because the Examiner alleges that the teaching of Pais et al. a nozzle submerged for cooling a low Z target material of a neutron source assembly. The Examiner's motivation is incorrect.

The liquid gallium of Lidsky et al. is incompatible with the system of Pais et al. because Pais et al. discloses passing the coolant over a block of copper. As noted above, liquid gallium dissolves copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Lidsky et al. with the teaching of Pais et al. to realize a nozzle submerged for cooling a low Z target material of a neutron source assembly because the liquid gallium would dissolve the copper block of Pais et al.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the copper block of Pais et al., the proposed combination of Eggers, Lidsky et al., and Pais et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Pais et al. in that the system of Pais et al. would be rendered inoperable if liquid gallium were utilized as a coolant.

Furthermore, as recognized by the Examiner, Eggers, Lidsky et al., and Pais et al., singly or in combination, fail to disclose pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir, as set forth by independent claim 1.

Lastly, in addressing the Applicant's arguments, the Examiner dismisses the contention that the liquid gallium of Lidsky et al. is incompatible with the systems of Eggers and Pais et al. due to its corrosive nature and alleges that common sense would dictate the protective foil. What the Examiner is apparently contending is that obviousness can be based upon a combination of references wherein the secondary reference would destroy the primary reference when merely incorporating the subject matter therein.

The Examiner appears to contend that the ordinary skill artisan would take these references, since the references teach away from each other, and be motivated to start experimenting with other combinations of materials to find a solution so that the references could be properly combined without encountering the destruction if combined without the experimental modifications.

Moreover, the Examiner is apparently ignoring the whole teachings of the secondary references to justify a combination that, without purposely ignoring the entire teachings of the references, would steer the ordinary skill artisan away from such a combination. The secondary reference must be considered for their entire teachings, especially when the references as a whole teach against the combination proposed by the Examiner.

In summary, the proposed combination of Eggers, Lidsky et al., and Pais et al. fails because the teachings of Lidsky et al. would rendered the system of Eggers and the system of Pais et al., both, inoperable if liquid gallium were utilized as a coolant. Moreover, the proposed combination of Eggers, Lidsky et al., and Pais et al. fails to disclose or suggest pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir, as set forth by independent claim 1.

Independent Claim 5

As submitted above, independent claim 5 sets forth a neutron source assembly having a liquid cooled target. The neutron source assembly includes an accelerator based neutron source including a low Z target material that is bombarded by accelerated particles to produce a neutron flux and a cooling system to circulate liquid gallium through the accelerator based neutron source to cool the low Z target material. The cooling system includes a nozzle, the nozzle being submerged in liquid gallium to provide a submerged jet of concentrated liquid gallium in a direction normal to a non-

bombarded surface of the low Z target material within the accelerator based neutron source. The cooling system further includes a reservoir of liquid gallium; a heat exchanger, and means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the accelerator based neutron source, from the accelerator based neutron source directly to the heat exchanger, and from the heat exchanger to the reservoir.

Initially, as recognized by the Examiner, Eggers fails to disclose cooling a low Z target material of a neutron source assembly with liquid gallium. To meet this deficiency in Eggers, the Examiner assets that Eggers can be modified by the teachings of Lidsky et al. because the Examiner alleges that the teaching of Lidsky et al. with respect to cooling a low Z target material of a neutron source assembly with liquid gallium is an acceptable equivalent to cooling with water as taught by Eggers. The Examiner's motivation is incorrect.

More specifically, the liquid gallium of Lidsky et al. is incompatible with the system of Eggers because Eggers discloses a neutron source assembly constructed of aluminum. Liquid gallium dissolves aluminum or copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Eggers with the teaching of Lidsky et al. to realize a system to cool a low Z target material of a neutron source assembly with liquid gallium because the liquid gallium would dissolve the aluminum neutron source assembly of Eggers.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the aluminum neutron source assembly of Eggers, the proposed combination of Eggers, Lidsky et al., and Pais et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Eggers in that the system of Eggers would be rendered inoperable if liquid gallium were utilized as a coolant.

Moreover, as recognized by the Examiner, Eggers, and Lidsky et al., singly or in combination, fail to disclose a nozzle submerged in liquid gallium. To meet this deficiency in Eggers, and Lidsky et al., the Examiner assets that Eggers and Lidsky et al. can be modified by the teachings of Pais et al. because the Examiner alleges that

the teaching of Pais et al. a nozzle submerged for cooling a low Z target material of a neutron source assembly. The Examiner's motivation is incorrect.

The liquid gallium of Lidsky et al. is incompatible with the system of Pais et al. because Pais et al. discloses passing the coolant over a block of copper. As noted above, liquid gallium dissolves copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Lidsky et al. with the teaching of Pais et al. to realize a nozzle submerged for cooling a low Z target material of a neutron source assembly because the liquid gallium would dissolve the copper block of Pais et al.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the copper block of Pais et al., the proposed combination of Eggers, Lidsky et al., and Pais et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Pais et al. in that the system of Pais et al. would be rendered inoperable if liquid gallium were utilized as a coolant.

Furthermore, as recognized by the Examiner, Eggers, Lidsky et al., and Pais et al., singly or in combination, fail to disclose means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the accelerator based neutron source, from the accelerator based neutron source directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth by independent claim 5.

Lastly, in addressing the Applicant's arguments, the Examiner dismisses the contention that the liquid gallium of Lidsky et al. is incompatible with the systems of Eggers and Pais et al. due to its corrosive nature and alleges that common sense would dictate the protective foil. What the Examiner is apparently contending is that obviousness can be based upon a combination of references wherein the secondary reference would destroy the primary reference when merely incorporating the subject matter therein.

The Examiner appears to contend that the ordinary skill artisan would take these references, since the references teach away from each other, and be motivated to start

experimenting with other combinations of materials to find a solution so that the references could be properly combined without encountering the destruction if combined without the experimental modifications.

Moreover, the Examiner is apparently ignoring the whole teachings of the secondary references to justify a combination that, without purposely ignoring the entire teachings of the references, would steer the ordinary skill artisan away from such a combination. The secondary reference must be considered for their entire teachings, especially when the references as a whole teach against the combination proposed by the Examiner.

In summary, the proposed combination of Eggers, Lidsky et al., and Pais et al., fails because the teachings of Lidsky et al. would rendered the system of Eggers and the system of Pais et al., both, inoperable if liquid gallium were utilized as a coolant. Moreover, the proposed combination of Eggers, Lidsky et al., and Pais et al. fails to disclose or suggest means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the accelerator based neutron source, from the accelerator based neutron source directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth by independent claim 5.

Remaining Dependent Claims

With respect to claims 4 and 7, the Applicant, for the sake of brevity, will not address the reasons supporting patentability for these individual dependent claims, as these claims depend directly from allowable independent claims 1 and 5. The Applicant reserves the right to address the patentability of these dependent claims at a later time, should it be necessary.

Accordingly, in view of the remarks set forth above, the Examiner is respectfully requested to reconsider and withdraw this rejection.

E. Rejection of Claim 8 under 35 U.S.C. §103

Claim 8 has been rejected under 35 U.S.C. §103 as being unpatentable over Eggers (US-A-5,392,319) in view of Lidsky et al. (US-A-5,784,423), Pias et al. (IEEE Article), and Alger et al. (US-A-4,141,224). This rejection is respectfully traversed.

As submitted above, independent claim 8 sets forth a liquid cooling system for a neutron source assembly. The cooling system includes a reservoir of liquid gallium; a heat exchanger; a nozzle, the nozzle being submerged in liquid gallium, to provide a submerged jet of concentrated liquid gallium in a direction normal to a non-bombarded surface of a low Z target material within the neutron source assembly; and means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the neutron source assembly, from the neutron source assembly directly to the heat exchanger, and from the heat exchanger to the reservoir.

Initially, as recognized by the Examiner, Eggers fails to disclose cooling a low Z target material of a neutron source assembly with liquid gallium. To meet this deficiency in Eggers, the Examiner assets that Eggers can be modified by the teachings of Lidsky et al. because the Examiner alleges that the teaching of Lidsky et al. with respect to cooling a low Z target material of a neutron source assembly with liquid gallium is an acceptable equivalent to cooling with water as taught by Eggers. The Examiner's motivation is incorrect.

More specifically, the liquid gallium of Lidsky et al. is incompatible with the system of Eggers because Eggers discloses a neutron source assembly constructed of aluminum. Liquid gallium dissolves aluminum or copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Eggers with the teaching of Lidsky et al. to realize a system to cool a low Z target material of a neutron source assembly with liquid gallium because the liquid gallium would dissolve the aluminum neutron source assembly of Eggers.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the aluminum neutron source assembly of Eggers, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Eggers in that the system of Eggers would be rendered inoperable if liquid gallium were utilized as a coolant.

Moreover, as recognized by the Examiner, Eggers, and Lidsky et al., singly or in combination, fail to disclose a nozzle submerged in liquid gallium. To meet this deficiency in Eggers, and Lidsky et al., the Examiner assets that Eggers and Lidsky et al. can be modified by the teachings of Pais et al. because the Examiner alleges that the teaching of Pais et al. a nozzle submerged for cooling a low Z target material of a neutron source assembly. The Examiner's motivation is incorrect.

The liquid gallium of Lidsky et al. is incompatible with the system of Pais et al. because Pais et al. discloses passing the coolant over a block of copper. As noted above, liquid gallium dissolves copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Lidsky et al. with the teaching of Pais et al. to realize a nozzle submerged for cooling a low Z target material of a neutron source assembly because the liquid gallium would dissolve the copper block of Pais et al.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the copper block of Pais et al., the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Pais et al. in that the system of Pais et al. would be rendered inoperable if liquid gallium were utilized as a coolant.

Furthermore, as recognized by the Examiner, Eggers, Lidsky et al., and Pais et al., singly or in combination, fail to disclose means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the neutron source assembly, from the neutron source assembly directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth by independent claim 8.

With respect to the teachings of Alger et al., Alger et al. discloses cooling system wherein the coolant leaving the target chamber 13 is returned to the reservoir 23. Moreover, Alger et al. discloses that the coolant in the reservoir 23 can go to either the pump 27 for cooling the target or to cooling system 28 for temperature reduction.

Thus, Alger et al. fails to disclose or suggest means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the neutron source assembly, from the neutron source assembly directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth by independent claim 8.

Since Alger et al. fails to disclose or suggest means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the neutron source assembly, from the neutron source assembly directly to the heat exchanger, and from the heat exchanger to the reservoir, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to disclose or suggest means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the neutron source assembly, from the neutron source assembly directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth by independent claim 8.

Lastly, in addressing the Applicant's arguments, the Examiner dismisses the contention that the liquid gallium of Lidsky et al. is incompatible with the systems of Eggers and Pais et al. due to its corrosive nature and alleges that common sense would dictate the protective foil. What the Examiner is apparently contending is that obviousness can be based upon a combination of references wherein the secondary reference would destroy the primary reference when merely incorporating the subject matter therein.

The Examiner appears to contend that the ordinary skill artisan would take these references, since the references teach away from each other, and be motivated to start experimenting with other combinations of materials to find a solution so that the references could be properly combined without encountering the destruction if combined without the experimental modifications.

Moreover, the Examiner is apparently ignoring the whole teachings of the secondary references to justify a combination that, without purposely ignoring the entire teachings of the references, would steer the ordinary skill artisan away from such a combination. The secondary reference must be considered for their entire teachings, especially when the references as a whole teach against the combination proposed by the Examiner.

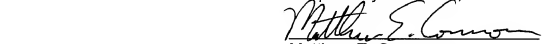
In summary, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails because the teachings of Lidsky et al. would rendered the system of Eggers and the system of Pais et al., both, inoperable if liquid gallium were utilized as a coolant. Moreover, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to disclose or suggest means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the neutron source assembly, from the neutron source assembly directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth in amended independent claim 8.

Accordingly, in view of the remarks set forth above, the Examiner is respectfully requested to reconsider and withdraw this rejection.

CONCLUSION

Accordingly, in view of all the reasons set forth above, the Examiner is respectfully requested to reconsider and withdraw all the present rejections. Also, an early indication of allowability is earnestly solicited.

Respectfully submitted,



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